Shipboard Guide to Pollution-Free Operations

U.S. DEPARTMENT OF COMMERCE

SHIPBOARD GUIDE TO POLLUTION-FREE OPERATIONS

U.S. DEPARTMENT OF COMMERCE
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UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Maritime Affairs
Washington, D.C. 20230

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To The American Mariner,

This Shipboard Guide has been conceived and developed with the objective of assisting you, the practicing seafarer, in an area that has become critical not only to your professional success but also to each of us in our dependency upon the sea.

The demand to control pollution of the seas has virtually become universal. The skilled Tankerman, as this Guide documents, is the "ultimate antipollution weapon." How well you do your job in this respect is, therefore, vitally important to everyone.

Our Nation needs a representative fleet of American-flag tankers. We also need highly motivated and competent licensed and certificated professionals sailing aboard these vessels.

I urge that you take to heart the message of this Guide and particularly note that 80 percent of petroleum pollution of shipboard origin is controllable.

This is your challenge! Your success will be a victory for all of us.

Robert J. Blackwell

ROBERT J. BLACKWELL
Assistant Secretary
for Maritime Affairs

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Chapter I

YOUR MARINE WORKING ENVIRONMENT

"Buzz words"—Today's language is full of words not saying much, but seemingly full of meaning and quick to become part of the everyday vocabulary. Press, advertisers, politicians and ecologists—all use them to get people to react. It's a convenient way of letting the public know, or think they know, what is going on in the world. Sometimes such words are misleading. They are so broad and general that, when related to a specific problem, they become almost meaningless.

Take, for example, "pollution," "ecology" and "environment." You may read in the newspaper about a prominent scientist who states: "Pollution is upsetting the ecology and destroying our environment." A man on the street in Los Angeles probably thinks of smog, air pollution, and streets clogged with automobiles. The same statement to an oysterman in Chesapeake Bay may mean oil, industrial waste and sewage in the water and the contamination of the oyster beds. A forest ranger in one of the national parks interprets it as crowds of people with trash and garbage to scatter, or the setting of forest fires.

It is our intent to give specific meaning to these and other words as they apply to ships, particularly tankships and tank barges and their respective operations. Then you will understand pollution and environment as they apply to you.

Your marine environment includes the sea, your vessel, and the air around and over the sea. In fact, your marine environment is everything that influences, or is influenced by, the sea. Oceans are a cradle of life and of weather, a global storehouse of water and energy, and a wealth of nutritive and mineral resources. They're vital to world trade, international relations and national defense. Since this is your seafaring environment you'll want to know how it functions.

Each day the earth's surface receives energy from the sun to produce food and oxygen and to circulate the water and air which keep man's life support system in balance. Since it covers 70 percent of the earth's surface, the sea is a vital part of this lifegiving system. It transforms solar energy into an awesome amount of chemical compounds and heat.

Organisms of the sea are born, live, breathe, feed, excrete, move, grow, mate, reproduce, and die within this single interconnected medium. The entire system is based on the natural phenomena by which plants produce basic organic material from inorganic substances and the successive and intricate steps by which organisms then return to the inorganic. Some organic material is carried to the sea by rivers, while some is manufactured in shallow water by plant life. However, more than 90 percent of the organic raw material for life in the sea is produced by a variety of plant-like floating organisms, i.e. phytoplankton, within the lighted surface layers of open water.

These pastures of plant cells are eaten by zooplankton and some small fish. They, in turn, are prey to various carnivorous creatures who have their own predators. Waste products from activity within the surface layers settle into dimly lit or unlighted layers of the sea. This process constantly extracts vital nutrients from the surface layers.

Materials from the surface travel to the sea floor where filter-feeding, burrowing animals and bacteria rework the particles. There is generally an abundance of oxygen in the deep water, and the solid bottom presents advantages that allow the support of a denser population of large creatures than can exist in deep mid-water.

In shallower water such as banks, wetlands, atolls, and continental shelves, the solid bottom warmer water and associated conditions enable rich populations to develop. Such areas constitute about 7 percent of the total areas of the oceans. In some of these regions, additional food results from the growth of large fixed plants and from land drainage.

Historically, the most important human uses of the oceans have been shipping and fishing. Recorded history reflects the use of oceans for transportation and for distributing products throughout the world. The greatest part of the total volume of products transported between countries today moves aboard ocean vessels. With few exceptions, ocean transportation is the cheapest form of transportation. Consequently, as the world's consumption of materials increases, the outlook for marine

transportation is one of ever-increasing tonnages carried in larger and more operationally complex vessels.

You must share the marine environment with other professions and industries. Fishermen harvest approximately 60 million tons of fish and shellfish per year to produce an annual income of billions of dollars. Half of this 60 million tons is consumed directly, while the balance is converted into fish meal. Speculation exists that a well-managed world fishery could yield many times the present output. Coastal waters are the most productive areas of the world's oceans, yielding an estimated 90 percent of the world's marine food resources.

Physical resources of the ocean include minerals and oil below and on the bottom, minerals suspended in seawater, seawater itself, and the shoreline carved by the action of the seas. It was once believed that only the continental shelf areas had petroleum resource potential, but discoveries of oil deposits in deeper water have revised this belief. In the mid-1950's, the production of oil and gas from outer continental shelf areas was negligible. In 1976, about 16 percent of the world's oil and gas production came from offshore wells.

New technology, including extraction from seawater, mining under the seabed, dredging and harvesting nodules on the ocean floor, makes it feasible to reach and extract mineral resources once considered inaccessible. Chloride, bromide, manganese, copper and nickel are among the resources now being extracted from the sea and seabed in significant amounts.

As we look increasingly to the sea for survival, we must be aware of the marine environment's role in supporting life on earth and must take steps to protect this life-support system from potential ravages.

Many harmful, undiluted wastes are being discharged into the oceans today. Their effects are cumulative. The damage adds up year by year, even though a problem is not evident until it has reached a serious level. Though disputed by some, it is generally accepted that the process is reversible and that, if a source of pollution is eliminated, nature will in time recover. Hence, the outlook is not totally bleak.

In recent years, there have been intensive studies of the oceans and aquatic life that have added much to man's knowledge of the environment and how it works. Many of these investigations are international in scope, bringing together scientists from all over the world. Despite political differences, differences in scientific approaches to the problem, and even differences in recommendations for corrective action, universal agreement exists on one point—*There is a limit to the degree to which man can upset the natural balance of the environment without serious adverse consequences for the well-being livelihood of all.*

Chapter II

THE THREAT TO THE ENVIRONMENT

The marine environment is a never-ending cycle of chemical and physical changes which support life in the sea. Everything in the system has checks and balances. Every organism, large or small, plays its part. The world goes on in this never-ending cycle—or does it? What happens if some part of this system is interrupted?

Suppose a tanker at sea washes tanks for clean ballast and discharges 500 gallons of oily tank washings into the water. The oil, lighter than water, floats on the surface forming a slick over a wide area. Carried for miles by wind and wave action, it finally settles on a remote marshland. Nobody sees or smells it. Nobody steps in it, and there is no harm done—right? *Wrong!*

Uncontrolled Killer

Oil in an uncontrolled state can kill marshland. Sunlight is prevented from penetrating the surface of the water, interrupting the life cycle. Figure II-1 shows diagrammatically what many scientists agree will happen. Some oil evaporates into the air from which it may fall out

later in fog or rain. An additional amount is dispersed by wind and spray, but most spreads out as a slick. The arrows below the slick indicate what happens to the oil in the water column. When oil engages debris such as sand or silt, it increases in specific gravity and sinks, becoming bottom sediment that will slowly leach into the water for years.

Oil entering the marine system is believed to have harmful effects on portions of the fragile ecological network. Some effects are immediate and obvious, such as the death of birds and shrimp or the coating of beaches. Other effects may not be so obvious, but can be even more damaging. Among these are the blocking of the production of food and oxygen by microscopic green plants, the inhibition of marine life's "sense of smell," which is vital to its survival, the accumulation of dangerous components of oil in food organisms, and changes in the marine environment that can make marine life more susceptible to disease.

Petroleum and its residues have been detected in approximately 650,000 square miles of open ocean, as well as in continental shelves, estuaries, and adjacent wetlands and lagoons. Laboratory analyses have indicated that more than half of the microscopic plants and animals in samples from these surface waters are contaminated with oil. Since pollutants spilled into the oceans are moved by surface winds and currents, a discharge into the sea can be transported great distances, affecting a larger number of marine plants and animals than might be expected. Thus, although pollution discharges principally take place in coastal waters or along major trade routes, evidence of some oil pollution has been found in the far reaches of the Arctic and Antarctic Oceans.

Control This Necessity of Life

Let's look at what's known about oil. Petroleum is a common but complex mixture of chemical compounds used for fuel, heating and the manufacture of a wide variety of products. Without its lubricating qualities, most modern machinery would not run. We live, work, play and are sheltered by its by-products and many livelihoods revolve around its transport and use. Modern society could not function for long without petroleum products. Petroleum is compatible with the environment when it is in a controlled state such as when it is:

- contained in a well, pipeline, ship, or tank,
- burning in an engine, or boiler, or furnace, or
- refined or treated for use in various applications or products.

The uncontrolled state is where the trouble begins. An accidental discharge caused by a vessel grounding or a bunkering spill can interrupt the ecological balance and become a threat to the environment.

Pollution Not Limited to Petroleum Products

Marine pollution certainly is not limited to petroleum products. Though oil is perhaps the most easily detected offender, some industrial wastes and chemicals may be even more harmful. Hazardous chemicals, such as chloroform, carbon tetrachloride, phosphorus, and sulfuric acid

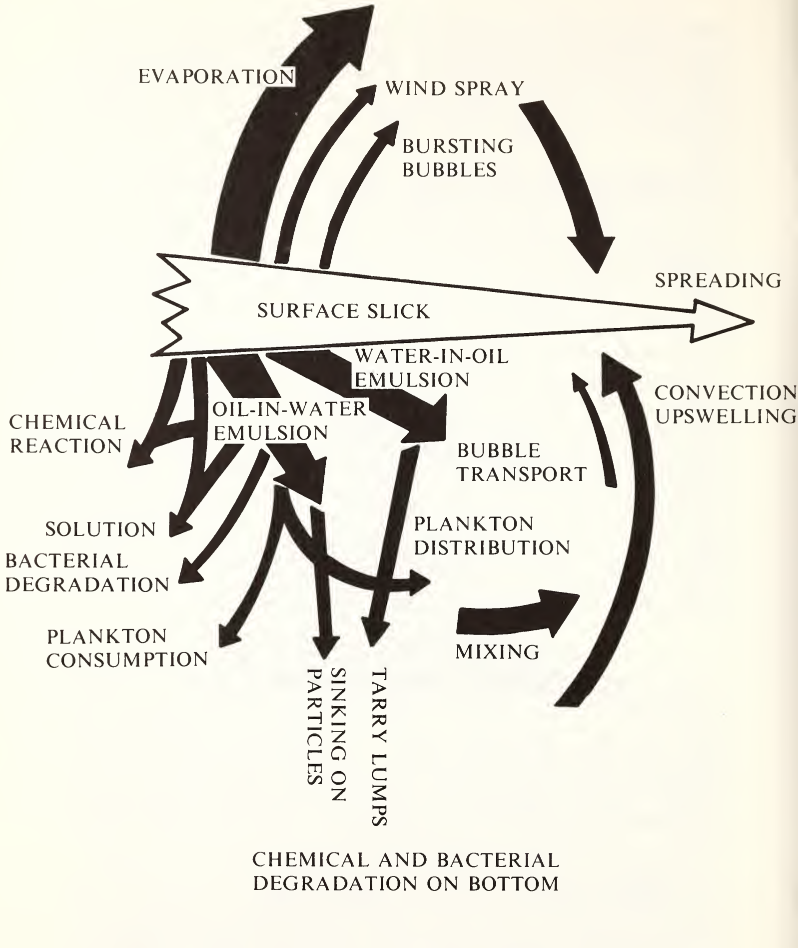


Figure II-1

DIAGRAMMATIC SUMMARY OF THE PROCESSES BY WHICH SPILLED OIL IS DISTRIBUTED AT SEA

are being transported in ever-increasing volumes. You may have also observed the ill effects of the uncontrolled or indiscriminate discharging of garbage and human wastes into the sea, particularly in confined locations where circulatory factors can cause large accumulations of these waste products.

Studies have revealed that many types of chemical dispersants used to clean up oil spills have been more harmful to aquatic life than the oil spill itself.

Pollution Attributed to Oil

Many studies and reports have been made to establish the quantity of marine environmental pollution attributable to oil. They do not necessarily agree. You need not be burdened with this conflicting data. Differences in sampling and statistical methods can account for a wide range of estimates. However, there is one similarity in these studies and reports—the potential source categories. With only a few exceptions, such as natural seepage and major ship catastrophies, oil spills occur because "somebody didn't know any better" or "somebody didn't give a damn."

One authority ranks several major sources of oil pollution in the oceans in order of magnitude as:

1. Automobile crankcase oil disposal
2. Tankers
3. Tank barges and other vessels
4. Waste oil from industrial machinery
5. Refinery/petrochemical plant disposals
6. Offshore production

The Coast Guard estimates that 1.4 million metric tons of oil pollutants are discharged annually into the oceans by tankers alone, out of an estimated total of 3.8 million metric tons from all sources. Such estimates are highly controversial, with figures of up to three times these amounts sometimes quoted by credible sources.

Unfortunately, the relatively few tanker incidents, such as strandings and collisions that spill large quantities of oil at one time, receive most of the attention in the world press. However, all casualty-caused spills accounted for less than 200,000 tons annually in recent years. The remainder of the spills, well over one million tons if we utilize the Coast Guard's estimate, came from cargo operations, bunkering, tank cleaning, drydocking, bilge pumping and other operational functions. Even though large-volume oil spills make headlines, the real bulk of tanker oil pollution derives from activities which you as a tankerman take part in and most often can control.

Millions of Words and Thousands of Tons

Millions of words have been written into laws, regulations, company policies and shipboard instructions pertaining to the accidental discharge of oil and the disposal of waste oil products. Although improvement has been made in some areas, there has been an increase in oil transport traffic, creating additional exposure to accidental spills. The net result

has been an increasing quantity of oil pollution in all of the oceans of the world.

It is widely believed that the marine ecological system has the capability for self-purification. However, if segments of that system are interrupted by the introduction of harmful factors that destroy or upset the natural balances, the oceans will not remain clean. Think a moment—outside of natural seepage, volcanic eruptions or phenomena such as the "red tide," nature seldom, if ever, pollutes itself. Man is almost always involved where pollution occurs. *Many has created it! Man can stop it!* It is man's responsibility to eliminate pollution. *You* share that responsibility as a professional seaman.

Chapter III

POLLUTERS BEWARE

Today more than ever before we must consider the pollution threat to our marine environment. If unchecked, the future of mankind could be threatened. Fortunately, our society, through government, industry and private groups, is now aware that we must take steps to protect this precious part of our world.

Many national and international antipollution regulations have been developed for vessel design and operation.

We are not teaching a course in Admiralty Law, but readers who are especially interested in legal considerations may turn to Appendix B. At this point we only intend to highlight international pollution prevention conventions, national statutes and regulations, as well as the enforcement agencies for each. This will help you appreciate the everyday antipollution rules under which you must operate.

All Around the World

Unlike land masses, oceans have no boundary lines. Because oceans are truly international, no country alone can protect them from pollution.

Back in the mid-1920's, the United States with many other nations began cooperative antipollution efforts. At that time the cooperating countries prohibited oil discharges in their respective ports. After that ruling, interest lessened in antipollution efforts. But after World War II, with sea transport of oil on the increase, international interest in controlling oil discharges once again intensified.

In 1948, the United Nations Maritime Conference in Geneva drew up a convention creating the Intergovernmental Maritime Consultative Organization (IMCO). It was IMCO's job to look into the whole field of sea transport, in order to provide a way for nations to cooperate on technical matters affecting the safety of international merchant shipping. Under IMCO, the first major global attack on marine pollution took place. In 1954, a Conference adopted the International Convention on the Prevention of Pollution of the Seas by Oil. This very long-named convention, of course, could not be enforced until it received international ratification. But it did lay down some modest rules: its restrictions limited oil discharges to a maximum of 100 parts per million (ppm) within 50 miles of land, but there were no such restrictions on vessels beyond 50 miles. It also initiated a requirement that a vessel maintain an "Oil Record Book."

IMCO's early pollution-prevention activities were directed primarily toward control of vessel operational discharges resulting from tank cleaning and ballasting. But the TORREY CANYON accident in 1967 put a spotlight on a different kind of pollution—concentrated marine pollution caused by a martime disaster. The program IMCO undertook had two purposes. One was to prevent the recurrence of a similar incident. The other was to suggest and promote rapid and efficient pollution clean-up operations to minimize the effects of such a disaster, should one happen again.

In 1969, IMCO amended the 1954 Convention by adopting significant additional operational restrictions. The new restrictions were more stringent than the earlier ones:

—prohibition of *any* oil discharge whatsoever from the cargo of a tanker within 50 miles of land;

—definite limitations on the total quantity of oil (1/15,000 of the particular cargo being carried on the vessel) that a tanker may discharge on a ballast voyage outside the 50-mile zone and only when enroute;

—the instantaneous rate at which oil may be discharged outside the 50-mile zone while a vessel is enroute (not to exceed 60 litres per nautical mile);

—a new form of Oil Record Book which made the job easier for officials who had to enforce the provisions of the 1969 amendments.

A 1971 amendment was aimed at minimizing the amount of oil that could escape in a tankship accident. This IMCO amendment adopted requirements for tank arrangements and limited tank size in all tankers.

When the 1973 International Convention for the Prevention of Pollution from Ships was adopted, the maximum quantity of oil permitted to

be discharged overboard for new tankers was reduced to 1/30,000 of the particular cargo being carried. The basic oil discharge standards of 1969 were retained, but the following features were added:

—extension of the definition of oil from persistent oils to all types of oils, both crude and refined products;

—prohibition against bilge discharges from tankers and other vessels within 12 miles of land; outside this zone the oil content was restricted to less than 100 ppm;

—requirements for segregated ballast tanks on all new oil tankers of 70,000 DWT and above contracted for on or after January 1, 1976, or delivered after January 1, 1980;

—designated geographical areas where oil discharge is completely prohibited (Persion Gulf, Mediterranean Sea, the Red, Black and Baltic Seas).

The 1973 Convention also adopted regulations covering noxious substances, sewage, garbage and solid waste.

One year after ratification by 15 countries representing half of the world's merchant shipping, this convention will come into force, superseding the 1954 International Convention.

Our National Waters and Shores

The U.S. Coast Guard (USCG) and the U.S. Environmental Protection Agency (EPA) are the principal U.S. Federal agencies designated by law to publish and administer pollution control regulations. The EPA is responsible for publishing, circulating and administering different standards concerning the amount of harmful substances permitted to be discharged into navigable or contiguous waters of the United States.

The Coast Guard's responsibility deals with vessel operations, design, and equipment to meet applicable discharge standards.

The United States Congress has passed two principal water pollution control laws:

1. *The Federal Water Pollution Control Act of 1948*

   This law was originally written to deal with sewage and industrial waste. Amendments later shifted its emphasis to water pollution by oil discharges.

   In 1970 and 1972, amendments to the law permitted regulations to be developed concerning transfer operations, vessels and terminals. These amendments fixed cleanup liability on the party responsible for a spill.

   Discharging harmful amounts of oil into U.S. waters was prohibited. A requirement was established for mandatory reports to the Coast Guard for all spills. The reports were considered important enough to require penalties for the individual in charge of a vessel who failed to comply: $10,000, a year in jail or both. Such penalties exist in addition to assessed civil penalties for the spill itself.

   With regard to transfer operations, the Coast Guard issued Final

Regulations on Pollution Prevention for Vessels and Transfer Facilities, effective July 1, 1974. These regulations place significant responsibility on the person in charge of an oil transfer operation.

2. *Ports and Waterways Safety Act of 1972*
   This Act authorized the Coast Guard to establish, operate, and maintain port and harbor vessel services and systems. The Coast Guard was also assigned certain responsibilities regarding establishment of tank vessel construction and operating standards for U.S. flag vessels and foreign-flag vessels entering U.S. waters. To accomplish this, the Coast Guard has issued Final Regulations on Tank Vessels Carrying Oil. These regulations included features of the International Convention for the Prevention of Pollution from Ships, 1973.

It would be neither pertinent nor helpful to try to describe in this manual every scrap of international and national antipollution legislation. But you encounter so many and such varied operating restrictions every day, it is important that you have a clear idea of the moving force behind them and their authority.

Conclusion—The Oil Record Book

Additional mention should be made of the Oil Record Book as it applies to U.S. operators. It was revised by the 1969 IMCO amendments. It is available free of charge at Coast Guard Merchant Marine Inspection Offices to all master and operators of vessels subject to the Oil Pollution Act of 1961, as amended in 1973. The book remains the property of the U.S. Government. It is maintained on a voyage basis and requires specific entries each time certain operations take place on the vessel. Typical operations include ballasting, tank cleaning, slop tank discharge, etc. When pollutants are discharged or escape, circumstances and reasons for such discharges must be described.

The master is responsible for maintenance of the book and for its delivery to the Coast Guard Marine Inspection Office at the end of the voyage. If the vessel is employed in coastwise or domestic trades, the book need only be submitted quarterly in April, July, October and December of each year with the entries for the preceding three months.

Failure to comply with requirements for the book's maintenance can result in a $500 to $1,000 fine for the individual at fault. Intentionally false or misleading statements can make the responsible individual liable to a fine of $500 to $1,000 or imprisonment for a term not exceeding six months or both. This means that you as an individual, not your employer, can be held accountable for willful violations of the regulations. It is sometimes hard to understand the assignment of liability against the individual instead of his employer, but in this case, the obligation is yours . . . *so BEWARE, . . . KNOW YOUR RESPONSIBILITIES AND FULFILL THEM.*

Chapter IV

YOUR SHIP AS A POLLUTION FIGHTER

Many tools and devices are available to assist you, the seafarer, in your battle against pollution. One of the most important is your vessel itself. All the features that the owner, naval architect and builder of a ship consider during its design and construction that make it a good commercial ship also help in avoiding pollution. The vessel's hull and tank integrity, plus its numerous cargo and operational systems, provide the basic equipment to accomplish its mission in a pollution-free manner.

It is true that factors such as hull form and proportions, subdivision, structure and stability were incorporated into your vessel's design principally to meet operating and safety requirements for specific trades. However, the same factors resulted in many antipollution benefits. For example, there is the inherent ability of your ship to remain stable and afloat through proper hull subdivision of tanks, even though any tank or certain combinations of tanks might become damaged. This ability is a prime factor in making the vessel itself a major element of your pollution

fighting ability. In addition, proper hull form and structural design of the ship minimize the chance of structural damage in heavy seas. A ship must have sufficient longitudinal strength to prevent it from breaking in two as the result of hogging or sagging caused by improper loading procedures. The vessel must also have adequate local strength to take the stresses that develop during loading and discharging operations.

Maintenance of your vessel's structural integrity ensures that your ship will continue to be a pollution fighter. Therefore, you and your shipmates, in the course of everyday responsibilities, must be alert to any threats to the structural integrity and safety of the vessel. For example, when the cargo tanks are being cleaned or mucked out, those on the job should always inspect for damage, deterioration, or corrosion of the hull and must report suspected problems to the officer in charge. Corroded areas must be dealt with. If not, corroded tank steel may eventually permit leakage. To minimize corrosion and deterioration of cargo tank structures, protective coatings or paints are often applied to internal tank surfaces. There are proper maintenance procedures to follow after applying such coatings. The longer your vessel has been in service, the more important such inspections become to prevent leakage and pollution.

If a tank is breached as a result of structural failure, grounding or collision, a timely and effective emergency transfer of cargo helps to reduce the amount of oil released into the sea. The system on your vessel may consist of onboard piping arrangements or portable pumps already on board or transferred aboard in time of emergency. This emergency transfer of oil may help save an entire vessel, while at the same time limiting the amount of oil that is released into the marine environment.

Your cargo handling and ballast systems play an important role in avoiding pollution. Port time for loading and unloading must be made as short as possible consistent with safety in order to maximize your ship's earning power. However, great care is required on your part to make sure that the benefits of quick turnaround time are not negated by pollution incidents.

Standard operating instructions for cargo handling are valuable aids. Following them enables you to load and discharge in a way that does not exceed the designed limits of the ship's structure, piping, or venting system. As you can see, the basic ship systems and their proper use can be powerful allies in fighting pollution.

Your vessel's ballasting operation is a vital activity. Seawater is pumped into specific cargo tanks after the ship has completed discharge to maintain stability and seaworthiness during your return ballast voyage. The quantity of ballast she takes on can range from one-third to one-half her cargo deadweight. You must give serious consideration to the location of this weight, with vessel structural integrity and seaworthiness foremost in your mind.

Each tanker has its own ballast arrangement tailored to its particular hull and tank configurations. Large, modern tankers are generally de-

signed with a certain number of compartments planned solely as segregated or clean ballast tanks. Such tanks are not used to carry cargo; they are fitted with separate piping and pumping systems. However, there may be crossover piping connections in the pump room, therefore precautions must be taken in the use of such connections. An economic advantage of a separate or segregated ballast system, distinct from its antipollution value, is that cargo and ballast water can be pumped simultaneously, thus reducing ship's time in port for loading and discharge.

Special Antipollution Design Features

A number of design features are being investigated as aids to the prevention of marine pollution. They include: double bottoms, double sides, double hulls, multi-screws and segregated ballast tankage. Their actual installation aboard ship has been very limited, so evaluation has been difficult. However, new features will no doubt be more common in future tanker construction. As mentioned in Chapter III, future tankers over 70,000 DWT will be required to use separate or segregated ballast tanks. Except during the severest of weather conditions, this will largely eliminate the problems connected with discharging dirty ballast into the marine environment.

IMCO has also set limits on the size of cargo tanks to reduce the amount of oil outflow in the event of tank rupture. Cargo tanks on oil tankers must be so designed and arranged that the theoretical outflow of oil from a casualty does not exceed 30,000 cubic meters or 500 times the cube root of the deadweight, whichever is greater, but in no case to exceed 40,000 cubic meters. Limiting the amount of oil which may be released due to the breaching of a cargo tank reduces the danger to the marine environment of a catastrophic accident resulting in a major polluting incident.

Many ships are equipped with bow thrusters; some have stern thrusters as well. Thrusters improve maneuvering control of the vessel at speeds where the rudder begins to lose effectiveness. They often permit ships to be berthed with fewer tugs than would normally be required. This added control is useful in avoiding low-speed rammings with fixed structures that could rupture tanks.

To assist in the control of oil discharges related to tank vessel operations, the 1973 International Convention for the Prevention of Pollution from Ships adopted a requirement for shipboard oil discharge monitoring and control systems. When these systems are fully developed and operational, bilge discharge will be monitored to ensure that effluent does not exceed prescribed limits. Likewise, the oily waste from cargo tanks resulting from ballasting or tank cleaning will be more accurately discharged at a rate which does not exceed 60 litres per nautical mile—the legal limit outside the 50-mile zone.

The 1973 International Convention for the Prevention of Pollution from Ships adopted another requirement. Any ship of 400 gross tons or over shall be fitted with oily water separator or filtering equipment. This is planned for bilge discharge application. The equipment is de-

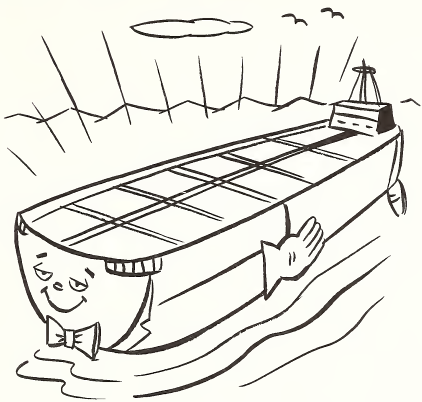
signed to restrict oily water discharges to 100 ppm of oil while the ship is beyond 12 miles from the nearest land and to 15 ppm when inside the 12-mile limit.

Shipboard navigational features and equipment help make ship operations safe and efficient. These features reduce the threat of pollution caused by vessel collisions, groundings, or rammings and can be considered pollution fighters. We have mentioned bow and stern thrusters for berthing or unberthing assistance. There are others: radar-plotting and collision-avoidance techniques, the Vessel Traffic Systems (VTS) being developed in many U.S. ports at the present time, and the numerous electronic navigational systems such as Omega, Decca, Loran and satellite navigation. Each of these shipboard aids must be well-maintained and used wisely. They can then help reduce the threat of pollution-causing incidents.

The entire vessel is at your disposal, and it's your responsibility. The proper use of its operating and control features will help minimize pollution resulting from the ship's operation.

Chapter V

OPERATING POLLUTION FREE



You have previously read that the U.S. Coast Guard estimates that 3.8 million tons of petroleum hydrocarbons are discharged annually from all sources into the sea. Of this quantity, approximately 1.4 million metric tons, or 37 percent, is attributable to tanker and barge operations. Some credible sources have estimated amounts up to three times these figures. Reports indicate that for every four to five barrels of oil deliberately discharged into the sea in ordinary operations, there is only one barrel discharged because of accidents.

Deliberate discharges include those related to ballasting, tank cleaning, and bilge discharge operations. Accidental discharges refer to spills resulting from vessel groundings and collisions, as well as cargo transfer and bunkering spills caused by equipment casualties and/or human error.

Your particular ship, its equipment, systems, and operational requirements probably vary widely from other tankers. But one thing all ships have in common is a need for an antipollution program that meets their individual problems. The following discussion of all routine operations will offer suggestions for antipollution procedures. While you read, you

can mentally review your own routine operations and consider whether some of the suggested antipollution techniques might fit into your own ongoing shipboard antipollution program.

Cargo Transfer

The loading and discharge of your vessel requires a sequence of preparatory steps and operational procedures. This would be true regardless of the amount or kind of cargo the ship carries. Some steps are standard, such as solving the loading problem; others vary according to the nature of the cargo(es) and/or the amounts to be handled.

Both the tanker cargo loading and discharge operations can be divided into three stages:

1. Preparatory
2. Transfer
3. Securing

Loading of Cargo

Preparatory Stage—Upon completion of discharge, your vessel receives orders to proceed to her loading port. The orders include the quantity and type of cargo to be loaded, its port of discharge, and other pertinent instructions. You devise a loading plan taking into consideration this information as well as special vessel requirements, trim, stability, etc. (Ballasting and tank cleaning will be discussed later in this chapter.)

After berthing at the loading terminal, appropriate personnel from your ship meet with terminal representatives for a transfer conference. The purpose of the meeting is to reach agreement on the primary cargo transfer operations. The group discusses and makes decisions about:

1. Vessel/shoreside communications procedures.
2. Cargo transfer sequence (for handling of multiple grades).
3. Cargo lines to be used.
4. Start-up, maximum, and topping off pumping rates.
5. Standby times prior to start-up, pumping rate changes, and pumping termination.
6. Emergency shutdown procedures for stopping and containing spills.
7. Special instructions covering vessel or terminal peculiarities, local requirements, etc.

A jointly prepared Declaration of Inspection is then endorsed by both parties.

In addition to regular annual tests and inspections, hoses should be inspected immediately prior to connection at the loading port and properly handled at all times. This reduces risk of spills during the transfer stage. Acceptance or rejection of hoses and connections, including gaskets, is the prerogative of your vessel. The choice must be made with care because it involves the "weakest link" in the entire

cargo transfer system. Therefore, evidence of leaking, abrasions, crushing, or other hose defects must be viewed very seriously. Clear identification of hoses is now a Coast Guard requirement. Labeling helps speed proper inspection. Proper use of the vessel's lifting bridles and saddles is important, and hoses must not be bent during handling to form a radius less than that recommended by the manufacturer. (A good rule of thumb is to not bend a hose in a radius in feet less than its diameter in inches.) Such inspections and precautions, although modified, also apply to chiksan arms or other types of terminal cargo line rigs.

Other preparations include plugging scuppers, connecting the bonding wire correctly, assuring adequate quantities of absorbing material, and blanking cargo risers not intended for use during the transfer.

If you have portable high-level alarms, you should make use of them. All sea valves or overboard valves in, or capable of being connected to the cargo lines, should be closed and secured. Adequate illumination is a *must* for transfer operations during hours of darkness, both for safety and for the early detection of any leakage or spillage.

Before pumping begins, your ship's officer-in-charge of transfer operations should order a check to ensure the proper lineup of pipelines and valves. Ideally, the officer-in-charge should make a final recheck.

Finally, the vessel/shoreside communication system must be tested, and if it is satisfactory, word can be passed ashore to start pumping.

Transfer Stage—Cargo transfer has now begun at the reduced start-up pumping rate agreed upon at the transfer conference. At this time you should make the first check that all hoses, loading arms and joints are free of leaks. It should be confirmed that the correct tanks are receiving the cargo. In addition, make sure that excessive pressure is not building up in hoses and lines. The water around the vessel is a final checkpoint for added assurance that all lines and valves are lined up properly and that there is no leakage.

If you are completely satisfied that the system is lined up properly and that there is no leakage, you may notify the shoreside facility to increase the cargo pumping rate to the maximum determined at the conference. Deck and engineering watches during cargo transfer operations must consist of enough qualified personnel to closely monitor at regular intervals all potential trouble spots. Primary check points for these inspections include the following:

1. Mooring lines and hoses to adjust for vessel draft changes and tidal effects.
2. Hoses, loading arms and hose connections for leakage, chafing, sharp bends, etc.
3. Line and hose pressures, so maximum limits are not exceeded.
4. Ullages of tanks being loaded.
5. Vessel's waterline for detection of any overboard discharge.

The loading progresses according to your planned tank loading sequence. As a prelude to smooth switchover procedures, ship's personnel

must carefully monitor the valves that control the loading of tanks nearing completion. It is necessary to gradually choke those valves, while simultaneously opening the proper valves for loading the next tank(s) in the loading sequence. Smooth switchover eliminates one of the main causes of surge pressure in the lines. Control of vessel listing caused by uneven tank filling rates is also important during the loading operations. Where tank sightings and/or ullage measurements are used to monitor the topping-off process, the officer-in-charge should assume personal supervision of the procedure. Close monitoring of the ullages of all tanks helps ensure that sufficient lag time exists between beginning to load an empty tank and completing the topping-off of a full tank within the tank loading sequence. If not, valves can be choked in and, if necessary, the pumping rate reduced. With the final closing of each full tank's loading valves, verify its proper seating. Ullages should be checked periodically, if possible, to ensure that no additional cargo is entering the tanks.

As the topping-off procedure nears completion in the final tank, you must notify the shoreside facility to reduce the pumping rate sufficiently to complete loading without any overflow. Finally, you notify shoreside personnel to cease pumping operations. Effective vessel/shoreside communications are critically important throughout this stage to facilitate an efficient cargo transfer. Proper communications can also ensure effective and immediate remedial measures, should some transfer emergency occur affecting either safety or the environment. Topping-off requires the undivided attention of all your vessel's watch-standers and takes precedence over other less important duties. If doubt exists regarding the status of the topping-off procedure at any point, you should order the terminal to shut down until the situation is clarified.

Securing Stage—Once pumping has stopped but before cargo manifold valves are closed, shoreside pipelines valves should be closed and the lines drained. Hoses must be carefully disconnected, blanked, and moved away. Manifolds are blanked, drip troughs emptied as necessary, and general cleanup proceeds.

Discharge of Cargo

Preparatory Stage—Preparation for cargo discharge operations begins when the cargo loading phase is completed and your vessel is underway for its port of discharge. Some products are carried at a specific temperature which has to be maintained or even raised to facilitate discharge. A discharge plan is formulated reflecting these requirements, as well as vessel trim, stability, and ballasting. When your ship berths at its discharge port, another transfer conference is held with shoreside terminal personnel to agree on the following points:

1. Vessel/shoreside communication procedures.
2. Cargo transfer sequence (multiple grades).
3. Available cargo line utilization.
4. Maximum pumping rates.

5. Emergency shutdown procedures.
6. Special instruction as to nature of vessel or terminal peculiarities, local requirements, etc.

Any cargo line valves not required during the discharge as well as sea suction and overboard discharge valves which are in, or capable of being connected to, the cargo lines, should be shut and secured. As with the loading phase, your proper inspection and handling of hoses is necessary to reduce the risk of pollution incidents during the transfer stage, regardless of the type of cargo connections used by the terminal. If there is doubt about the quality of a hose, you should reject it. Scuppers must be plugged, bonding wire connected, absorbing material made available, and adequate illumination provided if operations will take place during hours of darkness. These procedures are the same as in the loading phase and are required for the same reasons.

After securing the cargo hoses to the cargo manifold and after the shoreside facility signals its readiness to receive the cargo, the officer-in-charge should make a final check to ensure the proper line-up of all pipelines and valves. The vessel is now ready to start pumping.

Transfer Stage—After opening the cargo discharge valves, start the pumps slowly so all lines, hoses, and connections can be checked for leakage. The waterline of the vessel should also be checked for possible overboard discharge. When you have completed these checks without finding any problems, the discharge pumping rate may be increased gradually to the maximum agreed upon at the transfer conference. For as long as the discharge operation lasts, your watch-standers must routinely monitor the following potential problem areas:

1. Discharge pressure.
2. Lines, hoses, joints, and connections.
3. Mooring lines and hoses to adjust for vessel draft or tidal effects.
4. Vessel's waterline to detect any overboard discharge of oil.

Cargo tank soundings taken at regular intervals to measure the amount of cargo discharged should be compared with shoreside measurements. Any discrepancies must be accounted for, since these differences may indicate leaks in the system.

During your entire discharge operation, it is important to control vessel listing that might result from uneven tank discharge rates. Your stripping pumps will consolidate drainings from discharge tanks into a selected cargo tank.

There is a way to avoid excessive back-pressure in the shore line as the pumping operation winds down. By slowly closing a cargo manifold valve a few turns in advance of shutdown, it can be closed quickly at the last moment when the stripping pumps are secured.

As in the loading phase, the need for effective vessel shoreside communications in this stage cannot be overstressed, since it is a primary aid for a safe, pollution free operation.

Securing Stage—When pumping has stopped, all valves in the vessel's cargo system pipelines are closed. Discharge lines are flushed with seawater, the waste being pumped into your slop tank. Cargo hoses are carefully disconnected, drained, blanked, and moved away. Manifolds are blanked, and general cleanup begins.

Bunkering

Although this discussion of bunkering focuses on your vessel, a tanker, it is applicable to any type of vessel. The entire bunkering procedure is similar to the loading cycle of cargo transfer. Therefore, assume it proceeds in three distinct stages: preparatory, transfer, and securing.

Preparatory Stage—After your ship has been advised of its loading port, discharge port and cargo for a particular voyage, the major considerations of her loading plan will be the distance of the planned voyage and the bunkers required. Bunkering will often occur at your loading berth. An additional line can be brought aboard and the bunkering operation run simultaneously with the cargo loading operation. Bunkering can also occur in a discharge port, if expedient, and might be accomplished by taking an oil barge alongside your ship.

A major difference between cargo transfer and bunkering is that bunkering is under the direct supervision of your ship's Chief Engineer or his designee. While assistance and close cooperation are required from the deck department, the ultimate responsibility remains with the Chief Engineer.

As with cargo transfer, prior confirmation and agreement are obtained from shoreside terminal or barge personnel regarding numerous operational factors. Foremost among these are:

1. Quantity of bunkers to be loaded.
2. Pumping rates for start-up, maximum, and topping-off.
3. Standby times prior to start-up, pumping rate changes, and stopping.
4. Emergency shutdown procedures.
5. Special instructions, signals, communication techniques, etc.

A thorough inspection should be made of the hose. Proper use must be made of your lifting bridles and saddles in bringing it aboard. Any hose defects, such as abrasions, crushing, or evidence of leaking, should be noted and evaluated. You should reject the hose if doubts exist regarding its reliability. Such rejections should be noted in the Deck Log.

Scuppers must be plugged; fixed containers on enclosed deck areas at cargo manifolds must be plugged or else portable containers should be put in place; and absorbing material must be made available. If bunkering is to occur at night, proper lighting must be available in the work area. Accurate soundings should be taken of all fuel oil tanks to ensure that the bunkers to be received can be accommodated. Air vent pipes need to be inspected so that displaced air and gases can escape freely, and a portable container should be placed under the vents. A

final inspection should be made to ensure that all necessary valves in the filling line are open and properly lined up with the hose and appropriate connecting lines. You are now ready to start pumping.

Transfer Stage—Pumping starts at the reduced rate agreed upon at the conference, until a check can be made of all lines, joints, and hoses to make sure that there is no leakage. The pumping rate can then be increased gradually, followed by a series of soundings, pressure checks, and system integrity inspections. The filling valve(s) of the next tank(s) to be loaded in the loading sequence must be opened prior to closing the valve(s) on the tank(s) nearing completion. The delivery rate is reduced during topping-off.

As in cargo transfer, topping-off is a critical procedure and requires your undivided attention and effort. Be sure to allow enough ullage in the last tank to accept the terminal's displacement of bunkers remaining in the filling line. At the proper time, and with ample warning, the terminal or barge is ordered to stop pumping.

Securing Stage—Although pumping has ceased, the filling valves in the ship's oil lines are not closed until the terminal's valves have been closed and the hoses drained. Only then is the connection broken, and the hose and bunker manifolds blanked. All fuel lines and tank filling valves should be securely closed, and a final round of fuel oil tank soundings should be taken. General cleanup of the area follows.

Ballasting and Tank Washing

Both ballasting and tank washing aboard your ship are necessary, but both operations create the problem of disposing of the end product.

The discharge of oil waste related to tanker ballast handling and tank washing is one of the major causes of oil pollution in the world's oceans. Depending on the nature of the petroleum product carried, clingage and residue in a tank after discharge can range between .08 percent and .5 percent of the amount of cargo originally loaded. Dirty ballast or tank wash water discharged from such a tank obviously has a very high oil content. Still, it must be disposed of at some point to prepare for subsequent loading.

Ballasting—How much ballast your vessel loads and into which tanks it is loaded depend on:

1. Size, configuration, and handling characteristics of the vessel.
2. Ultimate ease of disposition of dirty ballast.
3. Nature of cargo carried in tanks prior to ballasting.

Your vessel may ballast 35 percent or more of her total deadweight tonnage. The merits of segregated ballast have come more and more under discussion in recent years. Segregated ballast is a system in which specific tanks aboard ship are designated solely for ballasting. Some new tankers have up to 30 percent of their total deadweight tonnage designed for this purpose. The 1973 International Convention adopted construction standards reflecting such systems, an indication of things to come.

Clean ballast has an oil content which produces no visible traces of oil when discharged on the surface of calm water (The No Sheen Test), and is commonly accepted as 15 ppm. It can be discharged anywhere. This applies to discharge from either a segregated ballast system or from a tank that has been washed prior to ballasting.

When a large volume of seawater is pumped aboard into dirty tanks for ballast, the immediate problem of its disposition arises. The 1969 Amendments to the 1954 International Convention for the Prevention of Pollution of the Sea by Oil impose a strict prohibition on the discharge of oil or oily mixtures within 50 miles of any coast. They also severely limit the flow, concentration, and quantity discharged anywhere else at sea. (Please see Chapter III.)

Outside the 50-mile limit, the restrictions on dirty ballast discharge by your vessel can be summarized as follows:

1. The vessel must be proceeding enroute, in other words, making one pass through the area.
2. The rate of discharge cannot exceed 60 litres per nautical mile.
3. The total oil discharged on a ballast voyage cannot exceed 1/15,000 of the total cargo carried.

Increased restrictions are being placed on at-sea discharges by international conventions as well as national and regional regulations. Therefore, new procedures and technology must be developed to comply with these restrictions while still getting the job done.

One familiar alternative procedure is the Load on Top (LOT) concept, developed in the early 1960's by a major oil company. The principles and mechanics of LOT have been described and explained very effectively in a set of two publications:

1. *Clean Seas Guide For Oil Tankers*
2. *Monitoring of Load on Top*

These documents were published by the Oil Companies International Marine Forum and the International Chamber of Shipping in 1973.

As stated in the *Clean Seas Guide,* "The essential purpose of the Load on Top system is the collection and settling on board of the water and oil mixtures resulting from ballasting and tank cleaning operations—usually in a discharge port." In some cases, compatible cargo can economically and practically be loaded on top of the oily water slops. The feasibility of this depends on the volume of "end product" mixture for disposition.

LOT was designed for vessels carrying the heavier grades of oil, especially crude, and is occasionally used by tankers carrying clean products. A major problem which exists is the system's slow rate of implementation by *all* vessel operators worldwide. For LOT to be effective, the process takes several days, requires strict adherence to the procedures, and demands vigilant supervision.

The percentage of in-service tankers using LOT procedures is not known exactly, but estimates run as high as 75-80 percent. It is also estimated that the remaining 20 percent not using LOT contributes up

to 80 percent of the oil entering the sea through operational discharges. The advantages of the Load on Top system are thus quite clear.

Technology has come a long way toward solving the problem of disposing of dirty ballast from black or persistent oils. Oil/water separator effectiveness has been improved tremendously and promises even further refinement. In-line oil content meters are available which under certain conditions can determine the oil content of ballast as it is being discharged. Detection equipment has also been developed which can determine accurately the oil/water interface in a tank of settled oily water. Thus, when the decanted water in the tank is being discharged overboard, adequate monitoring of this interface level can be maintained to prevent vortexing or weiring.

Technical progress is encouraging, but its acceptance and implementation by vessel operators remain a problem.

Tank Washing—Tanks on your vessel will generally be cleaned according to established routine, whether they are washed for clean ballast, tank maintenance, or "gas freeing." Tank washing methods include chemical cleaning and even the "crude washing system," but tank cleaning is usually accomplished by seawater under pressure. During washing, the dirty wash water from the bottom of the tank is pumped into a slop tank from which it is either pumped ashore or allowed to settle for eventual discharge overboard.

Tank washing with seawater can take two forms. A closed-cycle system, the more efficient from an environmental standpoint, is used only when cargo tanks have been inerted. It allows for the recycling of wash water by discharging tank washings into a slop tank and drawing settled-out wash water from the bottom. In the open-cycle system, wash water is continually drawn in from the sea, and the tank washings are discharged into the slop tank. Obviously, this system uses more water and, therefore, requires additional slop tank capacity.

The oil content in tank washings is very high. Sufficient settling out time in the cargo tanks is mandatory prior to decanting the clean water for discharge overboard and transferring the residue to the slop tank.

Slop Tank Discharge

The slop tank contains water with an extremely high oil content because it is the receptacle aboard your ship for tank washing and ballasting residue. Consequently, the disposition of its contents requires stringent monitoring and control procedures.

We stress that the first requirement for slop tank discharge is an adequate "settling out" period. If your ship is fitted with oily water separators, the oil-contaminated water may be pumped out by means of the stripping pumps. If no such separators are aboard, the decanted water is pumped overboard. But careful monitoring is required so that no oil waste exceeding the legal limit is discharged during the operation. The oil/water interface must be determined initially by meter or tape. It drops during the pumping operation and must be carefully followed primarily for the prevention of vortexing or weiring. Although

cargo pumps may be used, stripping pumps are preferable for this operation because large capacity pumps cause turbulence at the suctions. Continuous monitoring of the overboard discharge should be maintained by individuals trained to distinguish dirty water from oil-contaminated water.

Slop tanks should be discharged into shoreside facilities if adequate settling out time is not available or if your ship is enroute in a prohibited zone.

Bilge Discharge

The restrictions on your vessel regarding the pumping of bilges are common to all ships. In inland or territorial waters, you are prohibited from directly pumping overboard bilge water containing more than the legal limit of oil. Engine room bilges containing oil and oil/water mixtures should not be pumped overboard at any time. Article VII of the 1954 Internatoinal Convention for the Prevention of Pollution of the Sea by Oil requires preventive measures in the engine room that segregate fuel or diesel oil from water in the machinery space bilges. Oil accumulation should be transferred to a bunker or slop tank before risk of overflow exists. Before the vessel sails, accumulated oil-contaminated water in the machinery space bilges should be disposed of in a shoreside reception facility. If there is no shoreside facility, it should be pumped into a slop tank for at sea disposal after your ship has left the prohibited zone.

Sewage Disposal

Regardless of vessel type, the open ocean discharge of untreated but biodegradable vessel sanitary wastes is not considered a hazard to the marine environment. Its overboard discharge in inland and coastal navigable waters, however, is objectionable and may render the water unhealthy for aquatic life and recreational activity.

Vessels generate sewage at a rate of about 35 gallons per person per day. Many ships are equipped with onboard treatment facilities or holding tanks. Vessels with treatment facilities should maintain and use them to the fullest extent possible. Ships equipped with holding tanks should use them whenever they are within 12 miles of land.

Garbage and Trash Disposal

With the definite exception of nonbiodegradable refuse, depositing garbage and trash in the open ocean is not considered hazardous to the marine environment. In navigable waters of the U.S., however, all dumping is strictly prohibited by the Refuse Act of 1899.

Your ship should make full use of shoreside refuse facilities while in port. When at sea but within 12 miles of land, you should retain garbage and trash on board in proper facilities. Once outside the 12-mile limit, the ship can dispose of accumulated refuse, again with the exception of nonbiodegradable refuse such as plastic.

Stack Emissions

Stack emissions from all vessels are measured by the following criteria:

1. Smoke appearance or density.
2. Quantity and size of particles, if any.
3. Characteristics of emitted gases, fumes, or vapors.

Most states and many local authorities have strict air pollution laws regulating boiler smoke emissions, including those from ocean-going vessels. As a general rule, the Ringlemann Chart is the standard device for determining smoke emission density. This chart allows the comparison of existing stack emission color against a series of shade charts on a white background.

In shipboard boiler operations, upkeep and maintenance of burners are vital in avoiding violation of air pollution regulations in port. Checking and cleaning of all burners prior to arrival and frequent cleaning while in port should become routine. Obviously, you should not blow tubes while alongside the dock or at anchor.

A checklist of engineering "do's" and "dont's" should be developed and posted for use by your engineering watch-standers while your ship is in port. This will assist in minimizing any risk of air pollution. But it should become second nature to all crew members to keep an eye on the stack and to promptly advise the engine room of *any* stack emissions.

Chapter VI

POLLUTION CONTROLS AND COUNTERMEASURES

Your shipmates, as well as shoreside personnel, must be continuously aware of their duties in an emergency. Awareness of what actions to take, for example, in the case of a sudden problem in cargo transfer or bunkering operations, can minimize pollution.

Reaction to any accidental discharge of oil during cargo transfer or bunkering falls into three general categories:

1. Eliminating the source of pollution.
2. Reporting and containing the spill.
3. Cleanup activities.

Eliminating the Source of Pollution

When an accidental spill occurs, it may be caused by an equipment casualty, such as a burst hose or line, or by human error resulting in cargo tank overflow. You needn't speculate about the cause! The first

and most important thing to do is *Shut Down the Pumps!* In cargo transfer or bunkering operations, the importance of your prior agreement with shoreside personnel concerning emergency shutdown procedures becomes evident. The necessity of reliable vessel/shoreside communications speaks for itself.

In case of tank overflow, it is expedient to have an empty tank that can accept immediate diversion of the product flow. Diversion of the flow should supplement shutdown notification. If your vessel is discharging, you have greater emergency control of the pumps, usually from a nearby location remote from the pumproom. Once pumping has been stopped, appropriate cargo system valves should be closed to prevent further product loss. In the case of a leaking tank aboard a loading vessel, shoreside pumping must be stopped and the product shifted to an empty tank if possible. If shifting is impossible, the product from the leaking tank should be pumped back ashore. If your vessel is in the process of discharging, a damaged tank should naturally be discharged before any of the others.

Reporting and Containing the Spill

The Federal Water Pollution Control Act requires that in the case of a spill in U.S. waters, the person in charge of the vessel shall immediately notify the Coast Guard by the most rapid means available. The minimum information required is as follows:

1. Name of the reporting person.
2. Company and vessel name.
3. Where spill occurred.
4. Type of product spilled.
5. Approximate quantity.
6. Weather, tide and sea conditions.
7. Cause of spill.

Such information is used by the Coast Guard to determine the most effective cleanup action. When certain hazardous materials have been spilled, a follow-up written report must also be submitted to the Coast Guard within 15 days of the incident. Naturally, the master enters complete information regarding the spill in the vessel's logbook. Don't forget to notify the appropriate state environmental protection agency.

The capability of your ship to contain spills is restricted to whatever product stays on the vessel's deck and doesn't go over the side. In some cases containment equipment, such as floating boom rig, is included in a vessel's berthing arrangement by the terminal. If not, it is usually available to the facility on a shared commercial equipment basis.

Although your vessel doesn't carry this type of equipment, you may be in a position to help "jury rig" a temporary boom arrangement in an emergency involving a minor spill. However, the main effort should focus on containing the spill aboard the ship so that a minimum of product enters the water.

Cleanup Activities

As with containment capability, your ship is very limited in its ability to assist in the cleanup of oil in the water. However, you should assist to the maximum extent possible in efforts made by your agent or the terminal for commercial cleanup services. To expedite emergency containment and cleanup assistance, your ship should maintain current directories for all its usual ports of call. These directories should include names, addresses and telephone numbers for ordering these crucial services.

Mention should be made of the National Contingency Plan for the Removal of Oil and Hazardous Substances that was originally published in 1970 and has been revised several times. The Coast Guard and the Environmental Protection Agency share responsibility for coordinating the response to a spill of oil or hazardous substances in U.S. waters that results in a threat to navigable waters, shoreline or shelfbottom.

Chapter VII

THE ULTIMATE ANTIPOLLUTION WEAPON: A WELL-TRAINED CREW

The importance of the crew as the ultimate antipollution weapon cannot be over-emphasized. The critical factor in antipollution efforts is *you, the competent and motivated seafarer!* A well-trained crew can vastly reduce the risk of marine pollution from petroleum or hazardous cargo spills. It can also contribute substantially to:

1. More efficient use of the vessel and its equipment.
2. Increased efficiency of the vessel maintenance and upkeep.
3. Increased cost control effectiveness.

Competence

Your development as a professional seafarer has been a long and complex process. It was accomplished through some combination of formal shoreside education or training and extensive shipboard experience. When you reported aboard each new vessel during your

career, some degree of orientation and training, however informal, was needed. Since a tanker is a commercial vessel and not a training ship, orientation and training usually took the form of on-the-job training.

The basic responsibility for onboard orientation and training of personnel belongs to the master and the department heads. They must consider the background and experience of each new seafarer reporting aboard so as to determine the degree of indoctrination and training required. A realistic program that emphasizes personal duties and responsibilities will help the newcomer adjust to his surroundings. It will also reassure the department heads and the master that the ship is best prepared to operate pollution-free.

Your vessel's program should include the following general areas:

1. Familiarity with procedures, systems, and equipment related to the operation of the vessel.
2. Function and uses of equipment that may be unfamiliar to some crew members.
3. Shipboard safety programs, procedures, goals, and requirements.
4. Vessel antipollution goals, practices, and precautions.

Initial training efforts can lose their effectiveness if there is no day-to-day shipboard follow-up. This ongoing training should be continuous and consistent, emphasizing safety and antipollution techniques. It can be accomplished by:

1. Careful on-the-job supervision.
2. One-to-one informal instructional sessions.
3. Group instructional sessions at convenient times, such as extensions of fire and boat drills.
4. Training films or videotape cassette systems.
5. Special bulletins and posters.
6. A routine of fail-safe checks during operations that have the potential for polluting.

Training programs do not always fit easily into the routine aboard a busy ship; but, if all departments are committed to excellence in job performance, to safety, and to antipollution efforts, such programs can be maintained.

One last thought regarding indoctrination and training of those involved in the loading or discharging of petroleum cargoes—What about the night mates and night engineers? Are they fully and properly instructed before they become the "persons-in-charge"? If your training program finally produces a smooth working team, and then the responsibilities are turned over to a night relieving officer who is unfamiliar with the ship and its carefully developed procedures, your efforts could be wasted. *Don't let that happen!*

A shipboard equipment maintenance and testing program works cooperatively with job training to ensure safe and pollution-free operations. Maintenance and testing should keep records of the date, scope, and results of testing. This offers you an additional opportunity to become

familiar with the equipment so that you can operate it confidently and efficiently.

Another effective aid to your safe and pollution-free operation is the procedural checkoff list. If your owner has not provided one, prepare your own. Such lists are also very useful for operation of a particular system or piece of equipment. To reduce the chances of skipping some important part of a procedure or transposing steps in a sequence, simply post your checklists prominently. The risk of pollution is thus reduced.

Motivation

Operating pollution-free is certainly not completely ensured by the expertise of a fully qualified and certified crew. The crew must be *motivated* to make the most of that expertise in the performance of day-to-day duties. The development and maintenance of motivaion aboard your ship can bring you and your shipmates to a peak level of job-performance.

Individual motivation to work for the prevention of pollution begins with a personal understanding of pollution and the grave effects it can have on the marine environment. As a seafarer, you have probably felt anger about the unsightliness of oil in the water and the damage pollution causes to shorelines, coastal wildlife and inland waters. You are no doubt aware of the harsh penalties for violation of antipollution regulations. As a result, you do your best to abide by those regulations.

It is also useful to stay alert to the overall pollution problem, the total volume of oil that enters the sea annually, and the permanent damage suffered by marine life as a result of that pollution.

Such information is readily available to you and your shipmates; you need not read lengthy and technical materials to find out about it. Some shipboard educational programs are offered now on tankers, sponsored by either individual companies or organizations of national or international stature. The material is presented in readable and interesting newsletter and pamphlets that highlight the major aspects of oil pollution and its prevention. Another technique can be a monthly poster system, or possibly a pollution-control calendar featuring eye-catching illustrations which emphasize some antipollution practice or idea in a brief, lively way.

Antipollution programs of this type are essential if seafarers are to be continually reminded of their commitment to pollution-free operations and the shipboard techniques and efforts to achieve this goal. The seafarer must be impressed with the immediacy of the pollution problem as well as the value of his personal contribution to its solution. As each of your shipmates senses his personal stake in the fight against marine pollution, he will become that *"ultimate weapon against pollution."*

Positive motivation is certainly preferable to negative motivation created by the threat of penalties for the violation of antipollution regulations. Besides, positive motivation will carry over into areas of pollution prevention not covered by regulatory control.

Observers are often assigned by either the shipowner or the government to ride randomly selected tankers in order to monitor their pollution control. This practice is similar to the flight checks given to the crews of commercial airlines by company senior pilots or FAA representatives. Properly carried out, a "check ride" should highlight the problems of pollution, build knowledge, and develop that essential ingredient—*motivation.*

Chapter VIII

SHIPBOARD ANTIPOLLUTION COMMITTEE

To influence action and attitudes aboard ship, the Master has to plan and coordinate the antipollution programs of individual departments. With different duties and responsibilities assigned to each of the departments, some disagreement may arise about what is important, but this *need not* hinder a coordinated vessel effort.

The Master legally bears the greatest responsibility, but it is only through a total shipboard effort—a sense of shared responsibility for a common goal—that pollution-free operations can be accomplished.

One way to develop the awareness that a pollution-free operation is not only in the interest of the Master and vessel operator, but also benefits each and every member of the crew, is through a Shipboard Antipollution Committee.

The functions of such a committee would be to:

1. Improve, coordinate and foster departmental antipollution programs and activities into a unified shipboard effort.

2. Keep onboard pollution information up to date. Shoreside source materials, distributed by the Government, professional and technical organizations, and the vessel's operator should be used to best advantage.
3. Provide a sounding board for antipollution ideas, techniques and suggestions that may originate on board.
4. Evaluate for possible implementation antipollution ideas, techniques and suggestions which originate from sources outside the vessel.
5. Plan realistic antipollution educational training and motivational programs that comfortably dovetail with the vessel's operations and schedules.
6. Monitor ongoing programs as to content and effectiveness, and incorporate revisions where necessary.

Shipboard programs that foster safety and those that encourage pollution-free operations are related efforts. Many vessels have long-established shipboard safety committees to develop and support ongoing safety programs, develop motivation and monitor results. Such committees generally consist of:

1. The Master
2. Department Heads
3. The Senior unlicensed position in each department

Now is the time to consider a similar committee for your shipboard antipollution effort, or perhaps expansion of the scope of your safety committee to include the effort on behalf of the *protection of the marine environment.*

First, however, ask some questions. Is the membership and meeting frequency of your existing committee adequate? More important, do the purpose and role of the safety committee blend with the needs and requirements for an antipollution effort on your ship? If so, try using the existing safety committee for discussion of your vessel's antipollution goals and programs.

Borrowing the practice of most shipboard safety committees, documented cases relating to incidents of marine pollution can be reviewed and analyzed. Fail-safe practices can then be set up to prevent similar occurrences on your ship.

Working either in combination with the safety committee, or existing separately but paralleling it in organization, your antipollution committee can become an effective tool in reducing shipboard pollution. The committee can work for greater onboard awareness of the ongoing antipollution efforts of government and industry and thus can foster greater interest in pollution-free operations through a sense of individual participation. Reviewing case histories of true incidents, either on your ship or from reports circulated about incidents on other ships, can bring obvious benefits.

Short turnaround times and frequent personnel changes hinder the formation of a new committee or the expansion of the safety commit-

tee. These are realities, however, that can be turned to advantage since the new crewman is often receptive to absorbing quickly what is accepted operating procedure on his new vessel and thus will readily accept the fact that your ship gives high priority to pollution control.

Chapter IX

INCENTIVES AND AWARDS

Incentives

We have discussed various incentives affecting the seafarer's commitment to pollution-free vessel operations. Incentive generally falls into two catgories: positive and negative. Despite the fact that positive incentive is more meaningful and worthwhile, negative incentive (penalties or document revocation) appears at present to be the primary tool in fighting marine pollution.

Positive Incentive—Of all positive incentives, the individual's awareness of his personal stake in operating without causing pollution can be of the greatest value. A seafarer, who is aware of the existing problem and its ramifications and has witnessed the visible effects of marine pollution, is apt to perform his job more carefully and efficiently. An aware seafarer is genuinely concerned about the condition of the marine environment. After all, it's his own world, and he recognizes its increasing importance to all mankind in the future. The aware seafarer is concerned about what man is doing to preserve the marine environment, the importance it has for future generations, and the worldwide efforts

being made to avoid the degradation of the seas. He becomes indignant over the negative image that marine pollution has given the maritime industry and the adverse impact on his own career and livelihood.

You, as a seafarer, must develop and maintain the motivation to fight pollution in a concerted effort with your shipmates. The key to positive incentive, then, is *awareness*. Your first shipboard goal becomes one of ensuring that all hands are educated as to the nature and magnitude of the problem. Here lies the first real challenge for the Shipboard Antipollution Committee.

Negative Incentive—Negative incentive is more easily recognizable than its positive counterpart. Although effective, it does not impart the same quality of sustained motivation that can develop as a result of a positive approach.

Volumes of antipollution rules and regulations exist at international, national and local levels. They threaten polluters with all types of operational and financial penalties. They stress the vessel's liability when proper precautionary antipollution measures are not taken. These penalties threaten the seafarer with suspension or revocation of license or certification for personal negligence. There is no question as to the necessity of negative incentive in helping to foster pollution-free operations. Unfortunately, it usually generates grudging compliance that meets only the minimum legal requirements.

AWARDS

A shipboard antipollution effort that includes recognition or financial awards can be helpful. By itself, it does not fully reflect the importance of an ongoing vessel program, nor its appropriate spirit. Awards, however, can be an important tool in developing enthusiasm for antipollution efforts. They can represent valid recognition for a job well done.

Shipboard safety programs through the years have made extensive use of the awards system to reward shipboard performance. The same system could be applied to antipollution efforts, both to recognize vessel achievement and to reward individual action or suggestions.

Awards could be made on different levels, for example:

National environmental protection organizational awards:

1. Certification to tanker operators in recognition of effective fleetwide antipollution programs and/or fleetwide operational performance without incidence of marine pollution.
2. Certification awards to a vessel for pollution-free operations over designated periods of time.

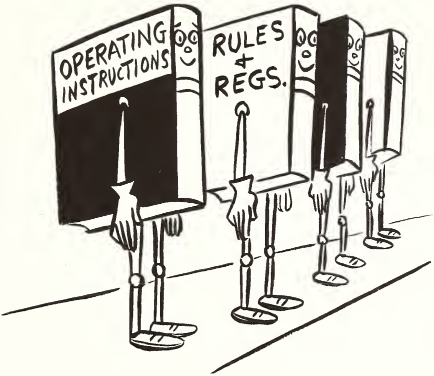
Tanker owner/operator awards to:

1. Particular vessels within the fleet for pollution-free performance over designated periods of time.
2. Individual crew members for extraordinary action taken to prevent or contain pollution aboard ship, or for effective and practical suggestions on how to help prevent ship-related pollution of the seas.

Incentives and awards must be recognized as only some of the means of helping to generate a team spirit among vessel personnel. Use them in conjunction with ongoing antipollution education and training programs. They can be one facet of a total approach toward the goals of operating pollution-free. Implemented properly aboard ship, incentives and awards are capable of generating interest and ideas among crew members concerning pollution prevention.

Chapter X

VESSEL ANTIPOLLUTION LIBRARY



The traditional function of shipboard libraries has been to provide ships' personnel with recreational reading material. Little emphasis has been placed on informational or technical materials to enhance the professional career development of the seafarer. With the development of shipboard safety committees and programs in recent years, safety-oriented materials for general distribution were introduced.

To help increase awareness of the existing pollution problem, you should make pertinent materials available to all crew members. Your shipboard library can be the facility for effective distribution of the information.

However, the simple provision of such materials is not enough. One function of your antipollution committee could be to encourage use of these materials through the generation of a personal interest in the environmental situation. The material might also encourage interest and participation in other aspects of committee work.

Your shipboard library could eventually include films relating to the topic or perhaps the newer video tape cassettes when they become available.

The list of environmental and antipollution references in Appendix C is recommended as a basic guide to the establishment of a ship's antipollution library. The list is lengthy, so first analyze your vessel, her mission, her trade routes and her particular problems; and then you will be able to determine which of the materials would provide the greatest benefit.

Appendix A

MARINE POLLUTION CASE HISTORIES

The following pollution mishaps caused by human error actually occurred and represent typical examples of damage to the marine environment and very costly cleanup operations. As mentioned throughout the manual, the importance of the individual, his attitude and his competent performance of his duties cannot be overstressed.

Case I—"ASLEEP ON THE JOB"

Early one morning in mid-1975, an oil barge was loading No. 6 fuel oil in a major East Coast port. What should have been a routine "topping-off" operation turned out to be a massive 2,500-barrel oil overflow, categorized as a major spill by the U.S. Coast Guard. Subsequent investigation into the cause of the spill indicated that the tankerman on duty had *FALLEN ASLEEP* and slept through the most critical part of the loading operation.

When the spill was finally discovered, the shoreside facility stopped pumping, the Coast Guard was promptly notified, and cleanup operations were begun. After the spill, the oil was about 18 inches deep at the water's surface, and 7,000 linear feet of containment booms were employed in an attempt to counteract the dispersing effects of tides and winds. Vacuum trucks were used along the shoreline to suck up that oil which drifted away from the immediate area. The time to cleanup the spill was estimated at one week, and original cost estimates ran in excess of $250,000. By the time cleanup was completed, the actual cost was approaching $350,000—a staggering price for a "short nap."

Case II—"POOR JUDGMENT"

In early 1976, a freighter in a Pacific Coast port was taking on bunkers from an oil barge. Two sets of tanks, one forward and one aft, were being loaded simultaneously, and as the after set neared its final stages of filling, the two engineers on watch noticed a malfunction and reading fluctuation in the gauge monitoring the after starboard tank. Since the fuel barge was getting low on oil and the engineers wanted to ensure having enough oil to complete the filling of the after tanks to a designated level before the fuel barge ran dry, the flow of oil to the forward tanks was reduced by partially closing the appropriate valves.

Subsequently, the gauge monitoring the after port tank indicated that the proper level of oil had been reached in the tank, and its valve was closed to stop further loading. However, the gauge for the after star-

board tank continued to malfunction, and the mercury level suddenly dropped to near or below the zero reading, indicating an empty tank. At the same time, an overflow alarm for the same tank sounded. Both engineers were aware of these two opposing indicators. It was decided to open wide the valves for the forward tanks to help reduce the flow of oil into the after starboard tank. The valve controlling the oil flow into the after starboard tank was then closed fully. Shortly thereafter, shoreside personnel observed oil spilling over the stern of the vessel on the starboard side, and the fuel barge was immediately ordered to stop pumping.

The after starboard tank had been overfilled, and oil had been discharged through three overflow vents onto the vessel's deck and then over the side. It continued to flow for approximately 20 minutes after the barge stopped pumping. The ultimate cost of cleaning up the spill was in excess of $350,000.

The question arises why pumping operations were not immediately stopped when the tank level gauge malfunctioned and the overflow alarm sounded, especially since the tanks were nearly filled and an ullage measurement could have easily been taken to resolve the discrepancy. Certainly the actions taken by the engineers were "too little too late," and more professional judgment should have been used.

Case III—"UNDER THE INFLUENCE"

In mid-1974 in an Atlantic Coast port, a fuel barge arrived at an oil terminal to load No. 6 oil. Water ballast had been pumped out prior to arrival and routine loading was underway when a relief tankerman came aboard to take over the watch. Without looking or inquiring, he decided to pump water ballast. Naturally, the water ballast was No. 6 oil, and only through quick action by a shoreside pumpman on duty, who stopped his own pump when he heard the barge's pump start up, was a major spill averted. As it was, approximately 1,000 gallons of oil were discharged overboard.

The Coast Guard was notified immediately and cleanup operations were started. Subsequent investigation indicated that the barge pumpman had relieved the watch in a *"state of inebriation"* which accounted for his serious operational error. Besides the damage to the environment, total cleanup costs exceeded $150,000.

Case IV—"VESSEL FINGERPRINTS"

The following case history is included, not because it illustrates the "human error" factor, but because it indicates the lengths to which authorities will go to track down polluters.

Not long ago, a quantity of oil approaching 100,000 gallons was "dumped" off the Florida Keys by a tanker preparing to load grain. Dispersed by wind and currents, the spill moved shoreward along a 60-mile front, ultimately creating extensive beachfront environmental damage.

The Coast Guard started the most determined and sophisticated

search for an environmental polluter in its history by compiling a list of almost 250 commercial vessels that were in the general area at the time of the spill. All of these vessels were boarded, and oil samples were taken from those determined to be suspect for matching with oil samples collected at the spill. Chemical analyses followed based on new laboratory techniques developed by the Coast Guard's Research Development Center in Groton, Connecticut, which identify indelible chemical "fingerprints" ships leave on oil cargoes. The investigation narrowed the search, and an arrest was made of a vessel's master who subsequently faced the threat of a $10,000 fine and/or a year in jail.

This use of improved technology to help track down environmental polluters is impressive and no doubt will play an ever increasing role in environmental protection efforts in the future.

Appendix B

POLLUTION CONTROL REGULATIONS

The scope and size of this manual do not allow for the total reproduction of pollution control regulations pertinent to its areas of discussion. However, the following list does comprise the nucleus of federal regulations dealing with the pollution control provisions on tankers. A working familiarity with these regulations, as well as their ready availability aboard ship, is recommended.

1. U.S. Coast Guard, Title 33, Code of Federal Regulations, *Subchapter O—Pollution*:

   Part 151—Oil Pollution Regulations

   Part 153—Control of Pollution by Oil and Hazardous Substances, Discharge Removal

   Part 154—Large Oil Transfer Facilities

   Part 155—Vessel Design and Operations

   Part 156—Oil Transfer Operations

   Part 157—Tank Vessels Carrying Oil

   Part 159—Marine Sanitation Requirements, Certification Procedures and Design and Construction Requirements

2. U.S. Environmental Protection Agency, Title 40, Code of Federal Regulations, *Subchapter D—Water Programs*:

   Part 110—Discharge of Oil

   Part 116—Designation of Hazardous Substances

   Part 117—Determination of Removability of Hazardous Substances

   Part 118—Determination of Harmful Quantities for Hazardous Substances

   Part 119—Determination of Units of Measurement and Rates of Penalty for Hazardous Substances

   Part 125—National Pollutant Discharge Elimination System (NPDES)

   Part 140—Marine Sanitation Devices, Standards of Performance

3. Council on Environmental Quality, Title 40, Code of Federal Regulations, *Chapter V*:

Part 1510—National Oil and Hazardous Substances Pollution Contingency Plan

4. U.S. Coast Guard, Title 46, Code of Federal Regulations:

   a. *Subchapter D—Tank Vessels*

   Part 30—General Provisions

   Part 31—Inspection and Certification

   Part 32—Special Equipment, Machinery and Hull Requirements

   Part 34—Firefighting Equipment

   Part 35—Operations

   Part 36—Elevated Temperature Cargoes

   Part 38—Liquefied Flammable Gases

   b. *Subchapter O—Certain Bulk Dangerous Cargoes*

   Part 153—Self-Propelled Vessels Carrying Bulk Dangerous or Extremely Flammable Liquid Cargoes

   Part 154—Self Propelled Vessels Carrying Bulk Liquefied Gases

Appendix C

RECOMMENDED MATERIALS VESSEL ANTIPOLLUTION LIBRARY

1. OIL POLLUTION CONTROL FOR TANKERMEN, U.S. Coast Guard, 1973
2. CLEAN SEAS GUIDE FOR TANKERS—THE OPERATION OF LOAD ON TOP, International Chamber of Shipping, Oil Companies International Marine Forum, 1973
3. MONITORING OF LOAD ON TOP, International Chamber of Shipping, Oil Companies International Marine Forum, October 1973
4. MAN IN THE LIVING ENVIRONMENT, A REPORT ON GLOBAL ECOLOGICAL PROBLEMS, sponsored by the Institute of Ecology, published by the University of Wisconsin Press, Box 1397, Madison, Wis., 1971
5. OCEANOGRAPHY: A VIEW OF THE EARTH, a book by M. G. Gross, Prentice-Hall, Inc., 1972
6. MAN'S IMPACT ON THE GLOBAL ENVIRONMENT, REPORT OF THE STUDY OF CRITICAL ENVIRONMENTAL PROBLEMS, sponsored by the Massachusetts Institute of Technology, The MIT Press, Cambridge, Mass., 1970
7. IMPINGEMENT OF MAN ON THE OCEANS, a book by Donald Hood, Wiley Interscience, New York, N.Y., 1971
8. POLLUTION AND THE MARINE INDUSTRY, Volumes I, II, III and IV, a report by Alcan Shipping Services Ltd., 1060 University St., Montreal, Can., 1971
9. IMCO 1973 INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION FROM SHIPS, FINAL ACT OF THE INTERNATIONAL CONFERENCE ON MARINE POLLUTION, November 1973
10. INTERNATIONAL PERFORMANCE SPECIFICATION FOR OILY-WATER SEPARATING EQUIPMENT AND OIL CONTENT METERS, adopted by IMCO, Resolution A 233 (VII), October 1971
11. TANKER SAFETY GUIDE (PETROLEUM), International Chamber of Shipping, 1970
12. TANKER TANK CLEANING RESEARCH PROGRAM, PHASE I, FINAL REPORT, prepared by Mines Safety Appliance Research

Company and Keystone Shipping Company for the U.S. Department of Commerce, Maritime Administration, March 1974
13. FINAL ENVIRONMENTAL IMPACT STATEMENT, MARITIME ADMINISTRATION TANKER CONSTRUCTION PROGRAM, U.S. Department of Commerce, NTIS Report No. EIS 730725F, May 1973
14. STANDARD SPECIFICATION FOR MERCHANT SHIP CONSTRUCTION, SECTION 70—POLLUTION ABATEMENT EQUIPMENT AND SYSTEMS, NTIS Report No. COM 72-11469, December 1972
15. TANKERS AND THE ECOLOGY, by J. D. Porricelli, et al., a technical paper included in the transactions of the Society of Naval Architects and Marine Engineers, Vol. 79, pp. 169-221, 1971
16. TANKERS AND THE U.S. ENERGY SITUATION—AN ECONOMIC AND ENVIRONMENTAL ANALYSIS, by J. D. Porricelli and V. F. Keith, a paper presented at the Intersociety Transportation Conference of the Intersociety Committee on Transportation, Denver, Colo., September 1973
17. REFUSE ACT OF 1899, 33 U.S.C. 407
18. PORTS AND WATERWAYS SAFETY ACT OF 1972, Public Law 92-340, 86 Stat. 424
19. MARINE PROTECTION RESEARCH AND SANCTUARIES ACT OF 1972, Public Law 92-532, 86 Stat. 1052
20. OIL POLLUTION ACT OF 1973, Public Law 93-119, 80 Stat. 372
21. INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION OF THE SEA BY OIL, 3 U.S.T. 2989 TIAS No. 4900, 327, U.N.T.S. 3, London, May 1954 (1961)
22. AMENDMENTS ADOPTED BY THE CONFERENCE OF CONTRACTING GOVERNMENTS TO THE INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION OF THE SEA BY OIL, 1954, 17 U.S.T. 1523, T.I.A.S. No. 6109, 600 U.N.T.S. 322, April 1962
23. 1969 AMENDMENTS TO THE INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION OF THE SEA BY OIL, 1954, IMCO Resolution A.175 (VI) adopted October 21, 1969
24. 1971 AMENDMENTS TO THE INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION OF THE SEA BY OIL, 1954, CONCERNING TANK ARRANGEMENTS AND LIMITATION OF TANK SIZE, IMCO Assembly Resolution A. 246, (VII) adopted October 12, 1971
25. THE INTERNATIONAL CONVENTION RELATING TO INTERVENTION ON THE HIGH SEAS IN CASES OF OIL POLLUTION CASUALTIES, Brussels, November 1969
26. INTERNATIONAL CONVENTION ON CIVIL LIABILITY FOR OIL POLLUTION DAMAGE, Brussels, November 1969

27. CONVENTION ON THE PREVENTION OF MARINE POLLUTION BY DUMPING WASTES AND OTHER MATTER, London, November 1972
28. REPORT OF THE UNITED NATIONS CONFERENCE ON THE HUMAN ENVIRONMENT, Stockholm, June 1972
29. A SYNTHESIS OF CURRENT INFORMATION ON TREATMENT AND DISPOSAL OF VESSEL SANITARY WASTES, National Academy of Sciences, Washington, D.C., July 1971
30. FEDERAL WATER POLLUTION CONTROL ACT Amendments of 1972, Public Law 92-500, 86 Stat., 816.
31. SURVEY OF REGULATIONS PERTINENT TO VESSEL STACK GAS EMISSIONS, Maritime Administration, National Maritime Research Center—Galveston, 1974
32. CLEAN AIR ACT OF 1970, Public Law 91-604, 84 Stat. 1676
33. CODE FOR THE CONSTRUCTION AND EQUIPMENT OF SHIPS CARRYING DANGEROUS CHEMICALS IN BULK, IMCO Resolution A. 212 (VII)
34. CODE FOR THE CONSTRUCTION AND EQUIPMENT OF SHIPS CARRYING LIQUIFIED GASES IN BULK, IMCO Resolution A. 328 (IX)
35. FINAL ENVIRONMENTAL IMPACT STATEMENT, BULK CHEMICAL CARRIER CONSTRUCTION PROGRAM, U.S. Department of Commerce, NTIS Report No. EIS 7302-74043F, August 1974
36. EVALUATION OF THE HAZARD OF BULK WATER TRANSPORTATION OF INDUSTRIAL CHEMICALS, a guide proposed by Evaluation Panel, Committee on Hazardous Materials, National Research Council
37. PROCEEDINGS OF THE FOURTH ANNUAL INTERNATIONAL CONFERENCE ON POLLUTION CONTROL IN THE MARINE INDUSTRY, International Association for Pollution Control, Suite 906, 1625 Eye St., Washington, D.C. May 1974
38. PROTOCOL RELATING TO INTERVENTION ON THE HIGH SEAS IN CASES OF MARINE POLLUTION BY SUBSTANCES OTHER THAN OIL, Final Act of the International Conference on Marine Pollution, 1973, IMCO, London
39. MANUAL ON THE AVOIDANCE OF POLLUTION OF THE SEA BY OIL, Department of Trade, London, England, 1974
40. REPORT OF THE IMCO SYMPOSIUM ON PREVENTION OF MARINE POLLUTION FROM SHIPS, Acapulco, Mexico, March 1976, published by IMCO, London
41. MANUAL ON OIL POLLUTION, DEALING WITH OIL SPILLAGES, IMCO, London, 1973
42. A MANUAL FOR THE SAFE HANDLING OF INFLAMMABLE AND COMBUSTIBLE LIQUIDS AND OTHER HAZARDOUS PRODUCTS, U.S. Coast Guard, CG 174, June 1, 1975

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